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Adaptive Reuse of Car-Oriented Urban Forms

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Report

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science in Community and Regional Planning

The University of Texas at Austin

May 2020

Adaptive Reuse of Car-Oriented Urban Forms

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In rising urban centers there is a growing trend toward densification and infill development coinciding with a decline in urban core car-dependency, rapidly shifting the demand for structed parking. By outlining the benefits to adaptive reuse, this paper makes the argument based not only on the value proposition to a potential developer, but through a wider benefit to the community. However, this paper is realistic about the inherent challenges to the reuse of parking garages. It is clear that parking garages have and will continue to be built with low ceiling heights and ramped floors, limiting opportunities for repurposing. Due to these circumstances, the construction of future parking garages should be designed with a transformative capacity that allows for a phasing out as demand decreases. The design of the structure can be informed by a specific future use objective or have the capacity to adapt to several alternative uses.

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Introduction

Car-oriented development has long plagued American cities with large swathes of the land base devoted solely for the purpose of serving vehicular traffic. With the drastic effects of carbon emissions on our planet becoming increasingly apparent, a new way forward must emerge. The wider understanding of these challenges has coincided with shifts in market demand for a more urbanized environment, with the public searching for more compact, walkable communities to call home. Additionally, recent shifts in mobility through new technologies in micromobility and automated vehicles have brought the sector into unprecedent transitional period.

Despite the eminent challenges and changes, the 20th century paradigm of auto-centric development patterns persist across the United States. However, some progressive municipalities have taken the hard steps to transition their built environment and regulatory framework away from the car. Across Europe cities have made inroads in the effort to reduce car traffic in their urban cores with Oslo phasing in a car-free future, Amsterdam pledging to eliminate more than 10,000 parking spaces, and London planning to ban construction of new parking facilities in much of the city. With the future of mobility uncertain, how should cities adapt their existing infrastructure and policies to prepare for the future and what should be done with the car-oriented relics of the past?

Chapter I introduces the problem of the current twentieth century paradigm of the car. Chapter 2 illustrates opportunities for reuse of parking structures by investigating existing and planned examples across the world. Chapter 3 introduces Austin, Texas as the case study for reuse applications in downtown areas within North America. Chapter 4 describes a methodology for an adaptive reuse suitability analysis. Chapter 5 investigates the adaptability of five existing parking garages in downtown Austin and displays potential adaptive reuse of two sites. Chapter 6 describes inherent barriers to adaptive reuse of structured parking garages and demonstrates design and policy solutions to future-proof parking structures. Chapter 7 concludes the report with lessons learned.

This report is intended to examine the possibilities for reuse of existing parking infrastructure and the rationale for its reuse, as well as to offer policy options to better manage the supply of parking and necessary transitions as transportation technology shifts. Research reveals a compelling argument for the need to find innovative solutions as the transportation sector continues to transition to a car-free future. The case studies and demonstrations in the reuse of parking garages are meant to shed light on the potential value engrained within existing structures in a rational argument for their reuse. By outlining the benefits to adaptive reuse, this paper makes the argument based not only on the value proposition to a potential developer, but through a wider benefit to the community. However, this paper is realistic about the inherent challenges to the reuse of parking garages. Documenting these challenges and posing potential solutions for development of policies that requires the design of parking garages with future renovation in mind adds value to current planning practice. This report describes options that speak to the need to better align parking regulations with goals of accessibility, sustainability, and affordability.

CONTEXT

Personal automobile traffic in dense urban areas creates congestion, reduces air quality, and presents a hazard to pedestrian and bicycle traffic. According to a recent report by the Texas A&M Transportation Institute, drivers in the United States spent an average of 54 hours additional commuting to and from work last year due to traffic congestion (Schrank, 2019). This time is functionally lost to the American people costing the economy nearly $179 billion in lost productivity each year (ibid). In urbanizing areas this level of congestion impacts the viability of mass transportation systems that are often forced to share the road with less efficient car traffic. Research indicates that high levels of automobile traffic can impact the air quality of surrounding areas dramatically, causing acute reactions as well as long term health impacts (Walton, 2015). Recent reviews of evidence by the World Health Organization indicate a clear relationship between high levels of particulate matter and nitrogen dioxide in the air--both common car pollutants--and the health outcomes of urban residents (World Health Organization, 2013).

Accidents involving a vehicle and a pedestrian or bicyclist are gruesome and dangerous affairs. According to the U.S. Department of Transportation's National Highway Safety Administration, nearly 6,000 pedestrians were killed in traffic accidents in 2016. The most vulnerable populations, including children under 14 and seniors over 65, make up a disproportionate share of those collisions at 37% of the total. In large urban areas across the United States (cities with a population above 500,000), pedestrian traffic fatalities make up a large share of the total number of fatalities each year with New York City topping this list at nearly 60% of all traffic related deaths (NHTSA, 2016). As more urbanites commute to work and travel to daily necessities by walking or biking, much more focus will need to be put into pedestrian and bike infrastructure to ensure a safe and comfortable experience.

However, the current car-centric model persists and is perpetuated by a vast array of car-supportive infrastructure. This includes a right of way network that allots a majority of its space to lanes dedicated to automobile traffic, vast highway systems that connect suburban commuters to downtown employers, and parking garages that store cars at the final destination. All together this system is estimated to consume nearly half of the total land area of urban space across the United States (Shoup, 2005). Parking garages, especially within the urban core, interrupt continuity of pedestrian flow, create safety issues, and decrease the liveliness of public space (Brown, 2011). Jane Jacobs notes that the more downtown activity is interrupted with parking lots and garages, the more the area sacrifices its essential strengths: compactness and variety (Jacobs, 1962). This is especially true of the ground floor, where the lifeless façade of a parking garage disrupts connections between active programs. Frequent interruptions in the sidewalk and bicycle network necessitated by the ingress and egress of vehicles at the parking garage present a potential hazard to pedestrian and cyclists.

There is rising evidence that reliance on the personal automobile in urban areas is directly linked to the availability and price of parking at the destination. Donald Shoup, a figure at the forefront of the growing discussing surrounding parking regulations and their wider impact, empirically studied the association between parking subsidies and commuting patterns in a 1990 report (Shoup, 1990). Shoup and his colleagues examined five case studies to determine how a change in employer subsidies for parking impacted employee mode choice. The case studies took two different approaches: one examined the commuting behavior of employees before and after employer-paid parking was eliminated, while the other compared the commuting behavior of matched samples of employees with and without employer-paid parking. The before/after case studies show short-term adjustments to shifts in parking supply while the with/without studies display longer-term changes in behavior. The case studies showed a striking link between subsidized parking and solo driving with an average decrease of 41% in solo driving, from 66% when employers pay for parking to 39% when employees pay for parking.

Literature and research on this subject has increased since Shoup's initial 1990 paper and continued to demonstrate the link between the availability of parking and commuter mode choice. Researchers at Virginia Tech contributed significantly to the literature through a regression analysis of revealed transportation preference data in the Washington D.C. metro area. This analysis modeled the effect of commuter benefits on mode choice while attempting to control for other compounding variables. From the results of the regression analysis, researchers were able to predict probabilities for mode choice outcomes based on different commuter benefit packages. The predictions showed free car parking led to 96.6% of commuters driving alone compared to 75.9% of those without free parking. It is clear that the access to convenient parking incentivizes solo car commuting, increases traffic congestion, and decreases transit ridership.

The cost of space in urbanizing areas has continued to rise, producing an affordability crisis in major American cities and further entrenching sprawling development patterns. Since 2012, 80% of the counties across the United States have witnessed increases in residential land values (Joint Center for Housing Studies of Harvard University, 2019). High housing costs are not only associated with the rise in land prices but also due to climbing construction costs. The construction industry's tight labor markets, with unemployment down to 3.2%, has inflated development costs (Joint Center for Housing Studies of Harvard University, 2019). This, along with the growing costs of materials, led to a 4.8% year over year increase in construction costs across the United States in 2019 (Anderson, 2019).

The rising costs of land and construction necessitates a lean building footprint that utilizes built space efficiently. Building out space for parking is a no small expense with the median cost per structured parking space coming in at $21,500 per space in 2019 (Cudney, 2019). This expense is not borne by the developer but is passed along to tenants and future owners in the form of increased rents and sales prices (Shoup, 1999). These cost increases are impacting American's bottom line, with a recent report from the Joint Center for Housing Studies of Harvard University finding that nearly half of renters countrywide are cost burdened, i.e., spending more than 30% of their income on housing and utilities (Joint Center for Housing Studies of Harvard University, 2019). In higher cost cities this affordability crisis is expanding into higher income brackets, with 70% of households in those cities earning between $30,000 and $44,999 considered cost burdened (ibid). This trend has pushed low- and moderate-income families out of city centers and urban neighborhoods and into suburban areas. New opportunities for affordable infill development are needed to quell the fast-paced growth of housing expenses in major urban areas.

There are currently 500 million parking spaces across the United States yet shifts in transportation technology, including the adoption of self-driving or autonomous vehicles (AVs), puts the future of these spaces, and some 3.5 million square miles of urban land, in flux. AV technology presents the prospect of one of the largest disruptions in recent history with the "potential to reduce costs by over $1 trillion, reduce CO2 emissions by a gigaton, and save tens of thousands of lives per year in the U.S. alone" (Walker, 2016). The Rocky Mountain Institute for Mobility Transformation recently published a report that attempted to model the potential market penetration of AVs across the United States. Their model indicates that within the first 20 years of introduction, AVs will consume nearly 70% of the private automobile market, following a similar trajectory to the advent of the color TV (Walker, 2016).

Proliferation of AV technology will have drastic implications for the demand of parking space in urban areas. Researches have begun to estimate how different variations of AV management and market penetration might impact parking demand with compelling results. The International Transport Forum modeled the changes in transportation patterns in different potential configurations of AV fleets. The researchers modeled two systems: a ride sharing system, where travelers share time and space resources by travelling in the same car simultaneously up to the capacity limit of the vehicle and cars may be owned privately or by a car fleet company; and a car sharing system, where travelers share time resources by travelling in the same car sequentially and car fleets are normally owned by a car fleet manager. The bottom-line figure from these models shows a reduction in parking need so vast that up to 80% of off-street parking could be plausibly removed. The Forum argues that a reduction this high necessitates an active management plan in order to lock in the benefits of any freed space (International Transport Forum, 2015).

Evidence indicates that the parking garage plays an outsized role in continuing car-oriented commuting patterns, has a particularly negative impact on the functionality of the urban core, compounds mounting affordability crises across cities in the United States, and is quickly losing its legitimacy as a useful building type going forward. In order to provide a more sustainable future for urban growth, the number of parking spaces will need to be systematically reduced both in the existing infrastructure and in planned projects. This reduction can begin with underutilized stand-alone parking structures. The need to better manage parking does not end there but must be part of a comprehensive approach to strategically align land use decisions with goals in mobility, affordability, and sustainability.

However, widespread demolition of existing parking structures is an untenable option. As Brown states, “knocking down existing garages to make way for new development will only perpetuate the cycle of waste which parking garages have come to exemplify” and instead a more sustainable vision will need to emerge (2011). Embodied energy - the amount of energy associated with extracting, processing, manufacturing, and assembling building materials - makes up an increasing proportion of the overall carbon emission from the built environment, particularly as power generation shifts towards less carbon-intensive technologies. Adaptive reuse expands the lifespan of built spaces, stretching a structure’s embodied energy over a longer lifecycle. Reusing parking structures as their utility dissipates presents a unique opportunity to realize goals in urban infill development without producing unnecessary waste.

Why Reuse?

ARGUMENT FOR REUSE

The reuse of parking structures in not a common practice and comes with many complications, which begs the question: why should these structures be preserved? The answer is twofold, with an environmental justification and an economic justification for the reuse of the existing structures. As preservationists often argue, the most sustainable building is, in fact, one that already exists (Belefante, 2007). This is due to the embodied energy of an existing structure. Embodied energy is the amount of energy associated with extracting, processing, manufacturing, and assembling building materials (Frey, 2007). As the price of urban land and construction costs continue to rise, the reuse of existing parking garages becomes an economically viable option over demolishing potentially adaptable structures. By and large, structured garages only exist where land values and opportunities are high, increasing the need for efficient use of land and capital in order to retain affordability. In addition, developers and landowners will need to find innovative solutions to generate a return on underutilized parking space as demand decreases going forward.

Embodied Energy

As innovations in renewable energy production, passive ventilation, and water conservation continue to decrease the carbon load of the ongoing operations of a building, more attention will need to be given to reducing the embodied energy of a building to meet sustainability goals. The construction industry in the United States is a particularly dirty affair. In 2003, the EPA estimated that 325 million tons of waste were generated from construction and demolition. This is no small share, making up 25% of the United States' municipal waste stream (Brown, 2011). A deeper look into the supply chain of this industry reveals harmful impacts besides overflowing landfills, with the release of toxics in the water stream and contaminating pollutants into the air a common occurrence in the resource extraction and manufacturing stages. The impact of the embodied energy of a structure means that, on average, when a building is demolished and replaced with a new energy efficient one, it takes 65 years to recover the energy lost through demolition and reconstruction (Frey, 2007). Parking garages are unique in that they lack interior mechanical and electrical systems and often do not have much in the way of a façade system or exterior skin. These features play an outsized role in building performance, accounting for 35% of the energy demand of a building according to a 2015 report by the U.S. Department of Energy. Integrating sustainable building systems, when combined with the conservation of the embodied energy, make the reuse of parking structures all the more enticing.

Decreased Demand

The falling demand for parking is expected to impact the revenue streams and investment performance of parking assets as new mobility technologies continue to shift the market. While this trend has not solidified and early signs of softening cannot be attributed directly to concerns over AVs, an initial analysis of the commercial mortgage backed security market for parking-dominated assets conducted by Robert Simmons appears to indicate underperformance when compared to peer asset classes (Simmons, 2020). Simmons and his research team conducted an analysis of 35 parking properties securing loans in CMBS trusts and found an annual unweighted depreciation of 2% between 2010 and 2017. It is clear that parking securities are underperforming when compared to the NCREIF Annual Property Index which shows positive appreciation in each of these years. In addition to the parking assets underperformance, bond interest rates appear to be showing signs of an increased perception of risk on parking-securitized loans. In 2007, the spread between U.S. Treasuries and interest rates of parking-securitized loans was roughly 200 basis points. In 2014, this spread had increased to 290 basis points and then to 325 basis points in 2015 (Simmons, 2020). The sample size for this analysis is too small, at only 15 parking-related debt instruments, to make a conclusive finding but does indicate a mild connection between the decreasing demand for parking and the viability of parking assets going forward.

CASE STUDY

Transitional

There are a limited number of cases studies of adapted parking structures, but each offer an insight into the complexity of the project and potential benefits if successful. Of the cases identified, two distinct techniques emerged. The first is a minimal intervention approach where much of the structure of the parking garage remains. This transitional method was used to create new social spaces and affordable work and retail space in once stale and lifeless structures. The second approach is a more comprehensive method, wherein a full adaptation of the building's systems occurs, and the final result is unrecognizable from its previous form. This transformation allows the new structured to be used as housing, office space, or other uses of varying degrees of affordability.

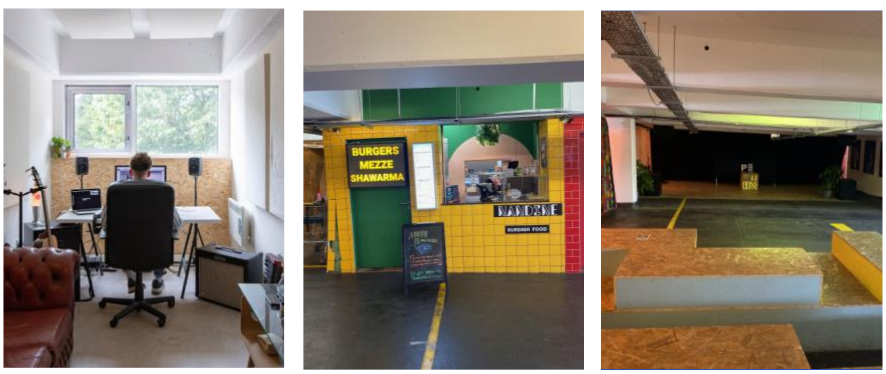

Figure 1- Interior Photos of Peckham Levels

Peckham Levels

Peckham Levels, a temporary renovation of a parking garage in the Peckham neighborhood of South London, offers a compelling case for the value adaptive reuse can bring to the local community. The project was developed by MakeShift, a non-profit placemaker working throughout South London, and designed by Carl Turner Architects. MakeShift is no stranger to innovative adaptive reuse projects with a proven track record of transforming underutilized land and structures into new community spaces. At Peckham Levels, MakeShift was able to transform a failing parking garage into co-working space, artists' studios, and community spaces spanning six floors in total. Studios, workspaces, and food vendors replace parking spots and the vehicular circulation system is transitioned into corridors for pedestrian movement. The redevelopment began in 2015 and was completed in late 2017 and is now home to over 50 small and independent businesses from the community (Simmons, 2020).

World of Food

The World of Food, nestled into Amsterdam's most diverse neighborhood, transitioned a portion of an underused parking garage into a thriving multicultural food court that has since become a gathering point for the community. The project, taken on by architect's Harvey Otten and Ted Schulten and developer Lingotto, came at the behest of the local government, which sought to create affordable space for local retailers and restaurateurs. The heavy concrete frame of the original parking structure gives the food court a unique character. Glass and steel for the project were reused from a garage that was demolished nearby (ArchDaily, 2015). The renovations began in 2014 and were completed in 2016 on a tight budget (Lingotto, 2016). Developer Lingotto still owns and manages the food court which now features over 30 vendors offering a diverse array of options from traditional Armenian dishes to Indonesian cuisine (ArchHello, 2015).

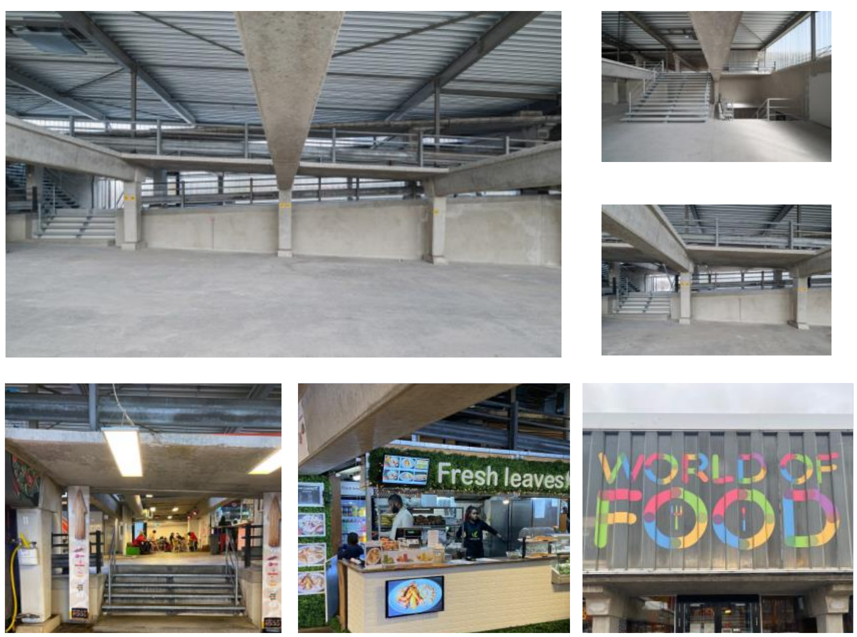

Figure 2: Interior photos of World of Food

The MOD

Perhaps inspired by the successful transitions of parking garage to public space highlighted above, the urban design and planning firm Gensler recently released a proposal to renovate a parking garage in downtown Los Angeles into a cultural center entitled "The MOD" (Walker, 2017). While only hypothetical in nature, renderings display how parking space could be systematically given back to the people in the form of high-quality public space. The fictional renovation displays the advantages of above ground, flat platform garages in terms of their potential adaptation to other uses. The MOD proposal came as a result of Gensler's continued research into the current state of parking with engineers and urban planners at Arup. The team's research highlights the need to identify and anticipate future infrastructural needs in design processes (Gensler Research Institute, 2016).

Figure 3 - Renderings of The Mod

COMPREHENSIVE

Other case studies demonstrate how a comprehensive renovation of an existing parking garage, where the building's systems are fully adapted to a new use, can produce commercially viable spaces for use as housing, hotels, office space, and distribution centers. This strategy requires parking structures that are more suitable for adaptation than a limited intervention conversion or else savings in construction cost and time will be lost. The existing structure's construction type, circulation method, and ceiling heights are all characteristics critical to a developer's ability to repurpose parking garages (Simmons, 2020).

Alton Plaza

Developer Saigebrook Development utilized clever financing incentives to transform a former parking structure in downtown Longview, Texas into a mixed-income community. The community, branded as Alton Plaza, converted the historic five-story structure into 48 housing units with 33 affordable to households earning 60% or below the area median income. According to media reports, the redevelopment was completed in 15 months with a budget of just under $10 million (Isaac, 2020b). Due to the historic status of the building and the developer's commitment to supplying affordable housing, the project received federal and state-level tax credits totaling more than $5.5 million as well as an upfront loan from the City of Longview of $600,000 (Isaac, 2020a). While the structure had fallen into disrepair and had been declared substandard in 2016, a previous renovation of the top three levels from parking to office space simplified its eventual conversion to residential units (Rees). The building's design includes many nods to the historic character including marble walls and a nostalgic diner on the ground floor.

Figure 4 - Before and After renovation at Alton Plaza

The Summit

The Summit, a 239-bed hotel and conference center in Cincinnati, Ohio, was transformed from a parking garage as demand for hotel and meeting space grew in the area. The existing parking garage housed 200 cars on a footprint of 86,000 SF with high, 21-foot floor-to-floor, ceiling heights. The transformed hotel features a large atrium that was cut through the building, reducing the load on the structure's existing columns and allowing for natural light to enter interior spaces. The construction began in 2015 and was completed in 2017. In all, the project cost $80 million to build ($216 per GSF) with hard costs making up 63% of the total budget. Initial cost estimates indicate that the reuse of the structure increased the project budget 20% over demolition and reconstruction. However, the owners elected to preserve the building in order to create a unique amenity for the neighborhood and expect to get a return on their investment over time based on higher rental and occupancy rates (Simmons, 2020).

Figure 5 - The Summit Hotel following renovations

Park House

In their recent proposal entitled Park House, architecture and planning firm KTGY showed the potential of combining adaptive reuse and prefabrication to quickly convert a parking garage in San Diego into 119 student housing units. The firm argues that the double-loaded central ramp parking structure is suitable for reuse because of the flat platforms that line the edge of the building. By removing the central ramp, the proposal encloses a community courtyard and brings in needed daylight to housing units. One- and two-bedroom units are constructed off-site in repurposed shipping containers and inserted onto the flat platforms that run along the perimeter of the structure (KTGY Architecture + Planning)

Figure 6 - Section, floor plan, and concept render of Park House

At A Closer Look: Austin, Texas

MOBILITY CONTEXT

Austin is a quickly expanding city in a growing metropolitan region in central Texas. In the downtown area there are over 4,500 residents and 92,000 employees, meaning almost 100,000 people populate the area on a daily basis (Census on the Map, 2017). The city has witnessed tremendous infill development within the downtown area and surrounding core neighborhoods (CBRE, 2019). The city offers an opportunity to better understand current parking trends and forecasts in urbanized areas within North America. This section provides background information on Austin, Texas; the subject of the parking structure adaptive reuse suitability analysis.

Traffic Congestion

Traffic congestion has increased in line with the tremendous population and employment growth witnessed in Austin. The Texas Transportation Institute at Texas A&M University (TTI) tracts traffic congestion indicators each year for major cities across the United States. According to the TTI's most recent Urban Mobility Report, the high traffic levels in Austin results in a delay of 66 hours per year for each commute, up significantly from 38 hours per year calculated in 2010. TTI estimates that this increase in congestion costs the average commuter nearly $650 per year in lost time and excess fuel usage (Texas Transportation Institute, 2019). This city's growing congestion woes are no secret to residents in the metropolitan area who bear the brunt of the problem on a daily basis. As this increase in congestion has occurred, private mobility technology companies have begun introducing disruptive technologies into a market eager for solutions and planners within city departments continue to offer a new vision for a multi-modal Austin.

New Technology

The Austin area has already seen how technological advancement and shared vehicle fleets will impact mobility patterns after a series a ridesharing and micromobility companies joined the city's transportation systems. Due to the lack of reporting requirements in the state of Texas, major ride-sharing companies Uber and Lyft do not regularly publish data on the number of trips completed in the Austin market (House Bill 100, 2017). However, non-profit ride-sharing startup, RideAustin, released a comprehensive dataset off all trips between June 2016 and April 2017. During this time, Lyft and Uber had ceased operations in the Austin area in response to the city's mandatory fingerprint requirements for all drivers on their platforms (Komanduri et. al., 2018). This increased RideAustin's relative market share during this period (ibid). The data reveals over 1.5 million trips during the period, equating to about 5,000 trips per day (RideAustin, 2017).

Mobility patterns in Austin have also been impacted by the emergence of shared micromobility fleets including e-scooters and dockless bikes. There are currently 86,922 registered micromobility devices in the city. At the top of this list is the 5,000 e-scooters registered by Lime and 4,500 e-scooters by Bird. Companies that operate these services in the city are required to report usage data as part of the city's operating protocols. Report data reveals there have been over 8 million trips across all the various mobility devices since operations first began in April of 2018 (City of Austin Transportation Department, 2020). The impact of ridesharing and micromobility fleets indicates that Austinites are not only open to adopting new modes of transportation but are growingly dependent on them for their daily travels.

Even more changes to mobility technology are on the horizon for the Austin area. The Rocky Mountain Institute for Mobility Transformation assessed which markets might see significant early adoption of AV technology based on market size and regulatory environment. Austin placed at the very top this list, with two other likely launch markets: Seattle and Phoenix. Their analysis estimates that the potential size of the AV market in Austin is over $2.5 billion based on predicted market penetration of the technology and estimated spending of early adopters. The penetration of AV technology is aided by the lack of city and state level regulations on the emerging AV sector and a long history of operations in the area. Google first initiated road testing of AV technology in the Austin area in 2015 (Batheja, 2015). Since Google's first test drive, Texas legislators have further clarified the state’s encouragement of AV road testing. Senate Bill 2205, passed by the State Congress in 2017, requires only that AV vehicles comply with traffic laws, be equipped with video monitoring devices, and maintain insurance in order to test drive on the state’s roads without an operator on board (Formby, 2017). The Texas Department of Transportation has since formed a taskforce devoted to coordinating all AV investments and initiatives taking place in the state (Weber, 2019).

A number of transportation researchers have already begun to model the impact that widespread adoption of AV technology would have in Central Texas. A 2015 report by the Center for Transportation Research (the Center), examined the impact that a low level of market penetration (1.3% of area-wide trips) would have in the Austin area (Fagnant et al, 2015). Despite the conservative market penetration modeled, results suggest that a fleet of shared AVs could serve intra-urban trips with a replacement rate of one AV for every nine conventional vehicles without a drop in service or increased waiting times (ibid). Building off of the first report, a second by the Center in 2017 simulated travel patterns of a shared AV fleet on Central Texas roadways based on reconstructed travel activity using MATSim. The results show a shared fleet of AVs can operate at a replacement rate between 5.9 to 7.7 conventional vehicles to every one AV and make up anywhere between 9.2% and 50.9% of total area-wide trips depending on fare rates (Liu et al, 2017). While these reports do not attempt to determine how many freed parking spaces a shared AV fleet might lead to, if the results from the International Transport Forum’s research (See Chapter 1) hold true, the Austin area is primed to witness a drastic decrease in parking demand going forward.

Changes in Behavior

Besides shifts in the mobility technology, there is clear evidence for a growing preference of walkable, bikeable, and transit-friendly communities in Central Texas. The 2016 comprehensive plan for the city of Austin, Imagine Austin, outlined a clear push for a built environment that is more conducive to multimodal transportation options based on more than 18,500 ideas and contributions from Austinites (Imagine Austin, 2016). The community’s plan is a vision for a more compact and connected city that favors densification through infill development over sprawling greenfield construction (ibid). Building upon the comprehensive plan, the City of Austin recently released an ambitious mobility plan that calls for a 50/50 mode share by 2039. A 50/50 mode share is defined as 50% of commuters driving alone to work each day while 50% use an alternative mode of transportation, i.e. transit, carpool, walk, or bike. In Austin, this means a nearly one third reduction in the percentage of commuters that drive alone to work each day, down from 74% at the time of the report. Reaching this goal is crucial to improving the quality of life for Austinites and to reduce the carbon footprint of the city as a whole. However, this also means a dramatic change to the transportation infrastructure will need to occur through this transition. As noted earlier, access to parking plays an outsized role in the mode choice of daily commuters presenting a key starting point for reaching the city’s ambitious mobility goals.

PARKING PLAN

This section looks closer at the current policies, trends in demand, and on the ground realities of parking in Austin’s urban core. This context helps to inform the site selection of parking garages for reuse. While these findings relate directly to Austin, they are representative of the many other metro areas in North America that are reckoning with expected shifts in transportation patterns, often in a patchwork fashion.

Regulations

Austin eliminated mandatory parking requirements in the central business district by city ordinance in 2013. However, this ordinance has only made a modest impact on the construction of new downtown parking structures. It has become clear that a laissez-faire approach is not sufficient to change the status quo of parking in downtown Austin. One of the most striking examples is the 405 Colorado office tower currently under construction by developer Brandywine Realty Trust. The project has a staggering 12 floors of structured parking with 2.6 parking spaces per thousand square feet of rentable office space. This equates to nearly half of the gross floor area of the building devoted to idle car storage. The scheme is eerily reminiscent of the office tower at 1100 Wilshire Boulevard in downtown Los Angeles that sat empty due to the building's dizzying 15 floors of parking (Shoup, 2011). Evidence indicates that a more strategic and actively managed approach to parking regulation is necessary in order to meet the goals outlined by the city's comprehensive and mobility plans.

Downtown Parking Strategy

The Downtown Austin Parking Strategy, a non-binding advocacy report published in 2016 by the Downtown Austin Alliance (DAA), attempts to provide the strategic planning necessary to successfully manage Austin's parking assets. The plan outlines pressing issues facing parking in the Austin's central core and offers a number of strategies to address the provision of parking going forward. As stated in the report, a comprehensive approach to addressing the future of parking in downtown Austin is crucial to maintaining continued growth, reducing congestion, tackling inequities in housing and transportation, and in preparing the city for the quickly evolving transportation sector. At the time of DAA's analysis there were 65,099 off-street parking spaces and 6,405 on-street spaces. Of the off-street spaces, 43% are available to the public, 25% are restricted, and the remaining 33% are split between public and restricted depending on the time of day. The average hourly rate for off-street spaces is $3.65, significantly higher than the averagely hourly rate for publicly managed on street parking at $1.20. This fragmented assortment of ownerhsip has led to a scenario where the highest parking demand is for the fewest available spaces, drivers are confused about their parking options, and a substantial share of existing parking is not efficiently used (DAA, 2016). This opens up opportunities for a comprehensive strategy that effectively manages the supply of parking and creates new uses for parking garages who lack demand for continued operations.

A small district analysis is essential to understanding the current parking capacity and how shifts in land use will increase or decrease the demand for parking within any given urban area. In the Downtown Austin Parking Strategy, the Downtown Austin

Alliance (DAA) created a framework for district level parking analysis that can be calibrated for use across different metropolitan areas (Downtown Austin Alliance, 2016). DAA's methodology, outlined in detail within its own report, segmented downtown into parking subdistricts based on a ½ mile walking shed, seen in Figure 7. Within each subdistrict, estimates of parking demand estimation are based on the Urban Land Institute's Shared Parking Manual and ITE's Parking Generation Model. Estimates are calibrated to the local context based on adjustments for inventory and occupancy, transit service, demand capture, and management policies. A demand vs supply gap analysis based on existing capacity indicates which districts have underutilized parking assets that may be suitable for renovation. Projected land use scenarios used for medium-term parking predictions for each subdistrict also offer a glimpse of the subdistrict's market conditions and what future program(s) may be viable in a renovated parking structure.

Overall, Subdistrict One is moderately suitable for adaptive reuse of a parking structure. The district's strengths are a lower demand for parking than what exists at present and the large impact that a shared parking strategy could have on increased parking demand going forward. The impact of shared parking is especially important considering the ongoing development of a large public government-owned parking facility at the State's new Capitol Complex just north of the State Capitol Building. Subdistrict Two also has lower demand than current supply and is forecasted to have the largest potential impact of shared parking in the medium-term. This is due to the complementary parking demand generated from office land uses during the day and demand from restaurant and bar patrons in the evenings (Downtown Austin Alliance, 2016). Subdistrict Three currently has a higher demand for parking than the current supply, mostly due to the peak period demands of the Austin Convention Center. The area's residential character, which makes up 40% of all land use in the medium-term predictions, makes implementing a shared parking strategy less effective at curbing demand. Subdistrict Four is notable because the area has a lower demand for parking than its current capacity and a large amount of office and hotel land uses that are more favorable for shared parking strategies.

	Existing Demand vs Supply	Medium-Term Demand vs Supply	Estimated Reduction in Demand through Shared Parking	Estimated Reduction in Parking Garages through Shared Parking	Estimated Increase in Building SF as % of Existing
One	Lower	Higher	-51%	24	140%
Two	Lower	Higher	-63%	17	20%
Three	Higher	Higher	-40%	28	110%
Four	Lower	Higher	-62%	45	30%

Figure 7 - Downtown Parking Alliance District Analysis Results

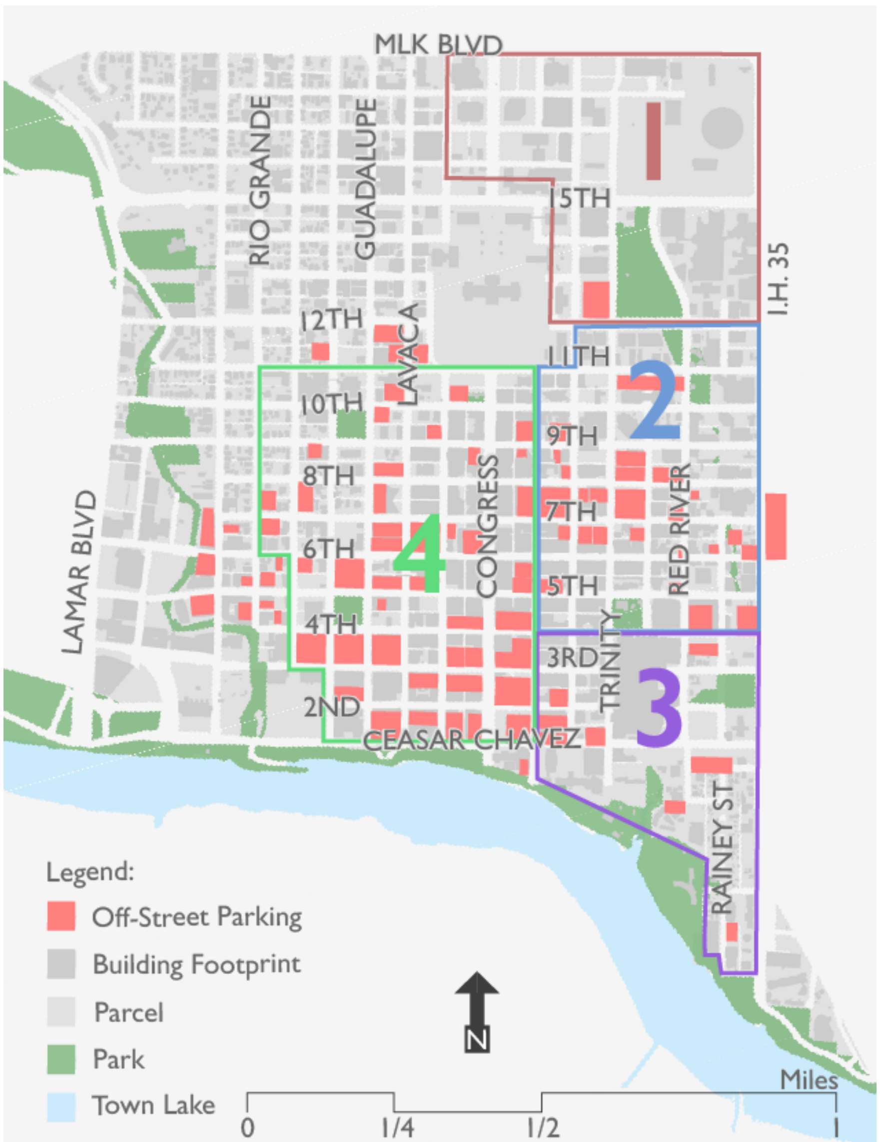

Figure 8 - Map of downtown Austin parking districts as defined by the Downtown Austin Alliance

Methodology

This chapter outlines methods of analysis for the selection of a parking garage suitable for adaptive reuse. The case study demonstrated that a spectrum of reuse will emerge, with some characteristics conducive to reuse and others adding another layer to the challenge. For these reasons, this methodology stops short of reaching ultimate thresholds on adaptability. Instead, attributes are assessed and totaled to an overall propensity for reuse score.

GARAGE SUITABILITY

A potential reuse site must be analyzed based on the structural composition of the parking garage, economic considerations, and the logistical aspects for implementing an adaptative reuse strategy. Lessons learned from the case study in Chapter 2 inform the criteria that help identify structures as being more conducive to renovation. These methods describe a baseline of characteristics that contribute to the adaptability of a parking structure. Due to the complex and unique characteristics of parking structures as well as the variety of renovation strategies, the results only indicate what qualities detract from reuse and what might facilitate an easier transition but do not attempt to establish outright thresholds.

A structure's suitability for reuse depends on a number of physical and non-physical characteristics, each impacting a structure's possible reuse in its own way. Characteristics that have a demonstrated ability to facilitate or hinder reuse were amassed through literature review and evidence gathered through case study. A five-point Likert scale or binary pass/fail test is applied to each characteristic in order to tabulate a final reuse suitability score for each test structure. Characteristics that contribute positively to reuse are given a + 2 score, characteristics that are moderately suitable for reuse are given a + 1 score, those that do not necessarily facilitate reuse but do not rule it out are given a score of 0, those that add moderate difficulty to the challenge are given score of -1, and characteristics that seriously hinder the adaptability of a structure are given a score of -2. The criteria for binary pass/fail tests follows a similar formula: characteristics that contribute to the adaptability of a garage are given +1 and those that take away from it are scored -1. Scores are then totaled to an overall suitability score for each structure. The criteria by which each characteristic is scored is outlined below.

PHYSICAL CHARACTERISTICS

There are nine standard designs of the standalone parking garage, each with different vertical circulation methods (Klose, 1965). The primary purpose of these designs is to provide the highest number of parking spaces within the smallest possible envelope (Pandya, 2016). This race towards single-use efficiency leads to circulation systems with continuous ramps, as seen in type 5 and 6, where a majority of a floor area is sloped. A variant to this group is the parking structure with a central ramp with flat floors along the exterior. This version has a significant sloped floor in the middle of the structure that is bounded by a flat platform for parking spaces. Generally, sloped floors are prohibitive to an adaptive reuse strategy; however, some of the case studies identified were able to make use of these structures in unconventional spaces and as interior circulation. Circulation methods with exterior ramp structures, as seen in types 2, 3, and 4, are more conducive to reuse but are less common in the built environment. Structures with flat floors but that do have interior ramps, as seen in types 1, 7, 8, and 9, can be reused if the remaining floor plates are large enough and sufficient daylighting can be achieved.

Looking at the circulation method and the percentage of the floor area that is sloped can indicate what parking structures could be efficiently reused and what might require a larger intervention to be suitable for a new use. Circulation types 5 and 6 are given a score of -2 and the central ramp variant is given a -1. Circulation types 2, 3, and 4 are given a score of +2. Lastly, types 1, 7, 8, and 9 are scored +1. Structures in which the sloped area constitutes 0 to 9.9% of the floor area are given a score of +2, those that have a sloped area between 10 and 25% are given a score of +1, and those that are sloped for over half of their floor area are given a score of -2. Due to the importance of these factors, they are double weighted in the suitability analysis.

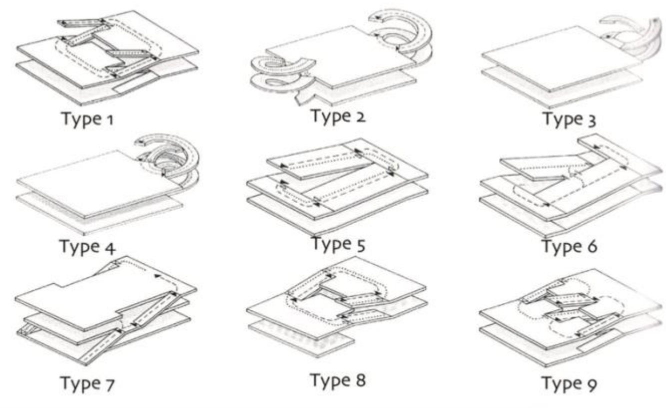

Figure 9 - Typical parking garage construction techniques

As stated earlier, garage structures were designed for single-use efficiency; thus, they often have lower ceiling heights than other uses. Residential and office uses require ceiling heights between 11 and 13 feet (Simmons, 2020). Parking structures with compatible heights are given a score of +2. Those with floor heights between 10 and 11 feet are given a score of +1. A score of 0 is assigned to those between 9 and 10 feet. Structures that have lower ceilings might require the systematic removal of levels to create double height spaces (Brown, 2011). While this renovation is possible, it adds significant construction costs. Structures with heights between 9 and 8 feet are given a score of -1 and those with heights below 8 feet are given a score of -2.

The floor plate in parking garages also differs from the standard floor plate dimensions of other construction types (Klose, 1965). In general, parking structures with inexorably large floor plates are more difficult to reuse because demolition would be required to allow light to penetrate the structure (Simmons, 2020). Different uses have different optimal floor plate dimension and floor area requirements, but general conventions can be used to determine if a given structure is suitable for reuse. For this purpose, floor plate dimensions that equate to a floor area below 20,000 SF are given a score of +2 because this is suitable for both office and residential construction. Those with a floor area between 20,000 and 30,000 SF are given a score of +1 and are suitable for office development. Those with floor areas between 30,000 to 40,000 are given a score of

0. Structures with a floor area between 40,000 and 50,000 SF are generally too large for residential and office development without structural changes, thus are given a score of -1. Those with a floor area over 50,000 SF are given a score of -2 but can still be adapted for more unconventional uses such as data and e-commerce fulfillment centers or for public uses such as food halls and community event spaces.

Other factors, including the structure's first-floor use and set back from the property line also contribute to adaptability. Structures which already accommodate commercial uses on the ground floor may be more easily adapted to a new use because some services necessary for renovation are already in place within the building, including HVAC and other mechanical systems. These structures are given a score of +2 and all other receive 0. The building's set back from the property line is an important consideration if renovations involve adding new elements to the building such as overhanging balconies or signage (Brown, 2011). Structures with adequate room for these enhancements are given a score of +2 and those located at the property line are given -2.

Physical Characteristics Suitability Score

	Floor Dimensions	Circulation Type	% of Sloped Floor Area	Floor Height	First-Floor Use	Set Back
+2	Less than 20,000 SF	Type 2, 3, & 4	0 to 10%	Greater than 11'		Greater than 12'
+1	20,000 to 30,000 SF	Type 1, 7, 8, & 9	10 to 20%	10 to 11'	Active Use	9-12'
0	30,000 to 40,000 SF		20 to 30%	9 to 10'	All Others	6-9'
-1	40,000 to 50,000 SF	Type 5 - Central Ramp	30 to 40%	8 to 9'		Less than 6'
-2	Greater than 50,000 SF	Type 5 & 6	Over 50%	Less than 8'		On Property Line

Figure 10 - Physical characteristics scoring schedule

NON-PHYSICAL CHARACTERISTICS

The ownership status of a parking structure is important to its reuse potential. The case studies examined show a strong connection between public and non-profit efforts and reuse of parking structures. In both Peckham Levels and World of Food, non-profit and public entities were critical in the planning and implementation of adaptive reuse strategies (Simmons, 2020; ArchDaily, 2015). Public involvement, especially in terms of providing financial support, was also crucial to the Alton Plaza development by Saigebrook Development in Longview, Texas (Isaac, 2020). Public and non-profit property owners are also exempt from ad valorem taxes. This property tax exemption disincentives the redevelopment or sale of property as development pressure rises, opening up more opportunities for reuse of underutilized parking garages. Structures owned by public or non-profit entities are given a score of +2 and all others are given a 0 score.

Other economic and logistical components play a role in adaptive reuse. The zoning of the parking structure is an important factor. While zoning can be changed, the path to a new use for the structure is much easier without the need for rezoning (Simons, 2020). Structures currently zoned for uses compatible to reuse, such as CBD, mixed-use, general office, or multifamily, are given a score of +2. All other zoning categories are given a score of +1. If the project is not to be pursued by its current owner, the cost to acquire the underused parking asset is another key component to reuse. The appraised value of the parcel can be used as a proxy for market value and can be factored into the reuse score on a project by project basis. Multimodal accessibility of the parking garage is an important factor, as the site will primarily be served by transit modes other than the car going forward. This can be approximated using the arithmetic mean of the walk, bike, and transit scores and should be graded on a relative basis.

Non-Physical Characteristics Suitability Score

	Multimodal Score	Ownership Type	Zoning	Appraised Value
+2		Public and Non-Profit	CBD, MU, MF	
+1				
0	Relative Score	All Others	All Others	Relative Score
-1				
-2				

Figure 11 - Non-physical characteristics score schedule

Adaptive Reuse Potential in Austin

SUITABILITY ANALYSIS

Characteristics of five parking structures were analyzed for their adaptive reuse potential in downtown Austin based on the methodology outlined in Chapter 4. A parking garage is selected for both a transitional renovation as well as a comprehensive redevelopment. Selection was informed by the parking district analysis within the Downtown Parking Strategy and is based on the physical, economic, and logistical characteristics of each parking structure. This forward-thinking analysis is crucial to better understanding the common challenges and strategic opportunities to reuse underutilized parking assets as their demand softens.

Figure 12 - Downtown Austin test structures

12th and Trinity

The State of Texas Capitol Visitors' Parking Garage, located at the intersection of 12th Street and Trinity, is reasonably suited for adaptive reuse. Located in subdistrict one, the structure is publicly owned and is zoned for multifamily development. However, the large central ramp, expansive floorplate, low ceiling heights are significant structural limitations to its potential reuse.

9th and Neches

The parking structure at 9th Street and Neches, owned by the First Baptist Church, is the highly suitable for conversion into a new use. The garage is located in subdistrict two, is owned by a non-profit entity, and is zoned for mixed use development. Its physical components are also favorable for reuse with flat split-level floors connected by a small ramp. The structure already contains retail on the ground floor and has floor dimensions and heights that are appropriate for residential or office use.

Rainey Street

The stand-alone parking structure adjacent to the Skyhouse Austin residential tower on Rainey Street is not suitable for adaptive reuse. The structure is privately owned by the same entity that operates the adjacent residential tower. While the structure does have appropriate ceiling heights and has active ground-floor uses, its sloping floors greatly diminish any repurpose potential for this structure.

8th and Lavaca

The situation is fairly similar for the parking structure at 8th Street and Lavaca. The garage has ramped floors with mid-level interchanges that, at 80%, take up a significant portion of the structure's overall floor area. The structure is also located along the property line, which makes adding balconies or other overhanging elements an impossibility. However, the structure is owned by a public entity in Travis County, is zoned CBD, and is located in one of the most accessible locations via public transportation. An innovative and potentially cost-intensive approach would be necessary in order to reuse this facility.

4th and San Antonio

The parking garage at 4th Street and San Antonio has a compelling case for adaptive reuse but does have some structural drawbacks. The garage, owned by the State of Texas, is just blocks away from the planned transit center at Republic Square making it highly accessible. The structure has flat floorplates on split level floors connected by two ramps. The garage has relatively high ceilings at 11’ and a sizable set back if any improvements are necessary. The structure’s large, almost square dimensions do make daylighting for residential or office uses a potential concern. However, a creative approach could turn the garage into a public amenity in a section of town undergoing significant infill development.

	Multimodal Score*	Ownership Type	Zoning	Appraised Value (in millions)**
12th and San Jacinto	80	Public	MF4	$21.00
9th and Neches	79	Non-Profit	DMU	$8.25
Rainy Street	80	Private	LO	$90.04***
8th and Lavaca	87	Public	CBD	$13.40
4th and San Antonio	88	Public	CBD	$14.70

	Floor Dimensions	Circulation Type	% of Sloped Floor Area	Floor Height	First-Floor Use	Set Back
12th and San Jacinto	340' x 220'	Type 5 - Central Ramp	36%	9'	Parking	12' off Trinity
9th and Neches	120' x 140'	Type 8	12%	10'	Retail	12' off 9th St
Rainy Street	200' x 150'	Type 5	40%	11'	Cafe and Retail	On property line
8th and Lavaca	100' x 275'	Type 6	80%	12'	Parking	On property line
4th and San Antonio	275' x 260'	Type 8	2%	11'	Parking	15' off San Anton

	12th and San Jacinto	9th and Neches	Rainy Street	8th and Lavaca	4th and San Antonio
+2	0	1	0	1	1
+1	3	9	2	5	8
0	1	0	0	1	1
-1	5	1	7	1	0
-2	1	0	2	3	1
Total	-4	10	-9	0	8

Figure 13 - Results of suitability analysis

TRANSITIONAL PROPOSAL

A transitional adaptive reuse strategy takes inspiration from the success of the World of Food in Amsterdam and Peckham Levels in London. Both examples demonstrate that even with minimal intervention, the life of a parking garage can be extended and given new purpose as public space. Ramped spaces are preserved as pedestrian circulation while flat floor plates are retrofitted into maker space, event space, or small eateries. This strategy has less stringent requirements in terms of physical characteristics but does require appropriate ceiling heights

Figure 14 - 4th and San Antonio parking garage

4th and San Antonio

Of the five test structures examined, the 4th and San Antonio Garage presents a great opportunity to test the application of transitional adaptive reuse because of its large floor plates, expansive roof, and central location. As noted in the suitability analysis, the structure's dimensions are difficult to comfortably transform into traditional office or housing floorplans. However, the space still holds the potential to be reimagined as a food hall for small vendors, classroom or laboratory space for a community college or maker spaces for rent to artists or non-profits, topped with a public roof-top park.

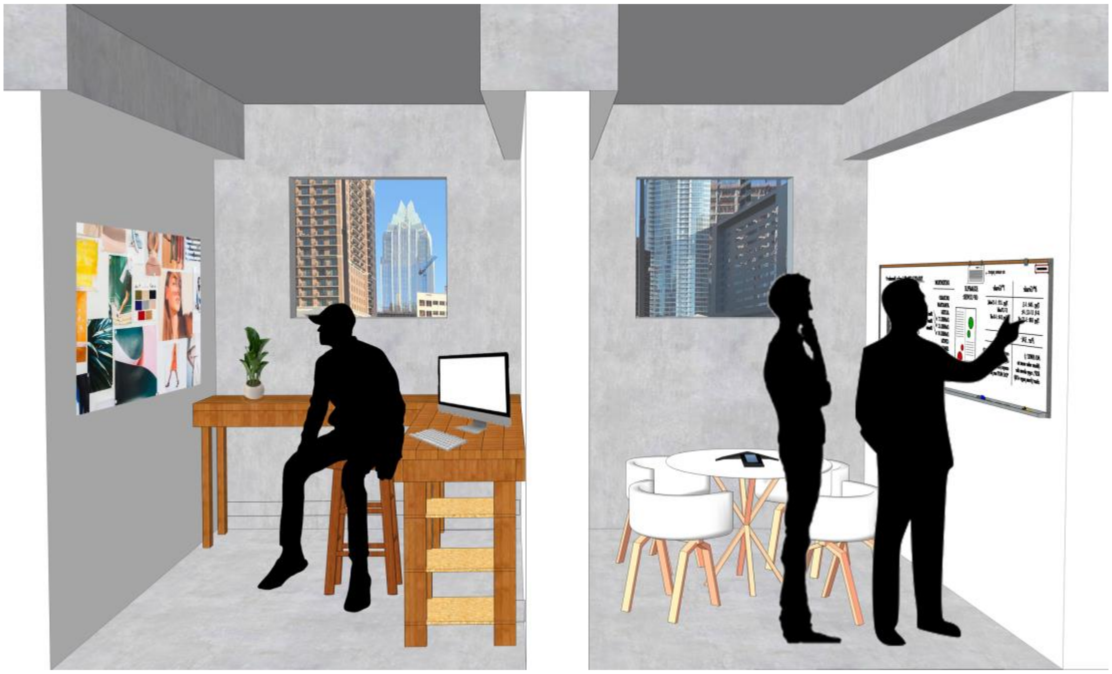

Figure 16 - Indoor maker space concept render

Figure 15 - Rooftop park concept render

Comprehensive Proposal

A comprehensive adaptive reuse is a full renovation of the parking garage's systems to facilitate its transition to a new use, such as office space or housing. Structural requirements are much more stringent for this type of renovation and can often require selective demolition of any ramped components (Brown, 2011). The Alton Plaza and The Summit examples demonstrate solutions to potential structural limitations including daylighting and structural load. While unbuilt, the KTGY proposal Park House, exhibits how combining adaptive reuse and modular construction can ease the conversion from parking garage to a new use.

Figure 17 - Parking garage at 9th and Neches

9th and Neches

The parking structure on the southwest corner of 9th Street and Neches has the highest potential to be suitable for a comprehensive adaptive reuse renovation. The structure's high ceilings, small ramps, and floor plate dimensions are all positive attributes for repurposing. Selective demolition of the ramps on either end of the structure allows the building's core to be reformatted into circulation for people rather than cars. The floorplates themselves are flat and have acceptable ceiling heights for residential use, making the conversion from parking spaces to housing units rather straightforward. Modular units providing for balconies and a 6' x 25' floor extension is added along the exterior to enlarge units and create a new façade for the structure. The existing first floor retail stays to maintain the active edge along 9th Street. In total, the converted structure accommodates 24 new housing units, each three bedroom and roughly 1,400 SF including the modular attachment. Depending on the unit layout, renovation could potentially accommodate a higher number of one- or two-bedroom units if desired.

Figure 19 - Housing concept render

Figure 18 - Renovation concept in context

Embodied Energy

Preservationists and sustainability advocates argue that existing structures represent the cumulative consumption of energy associated with the construction process. So-called embodied energy includes all energy and emissions related to the extraction, manufacturing, and transportation of building materials, the construction of the building, and the demolition and transportation of waste. These inputs are used to calculate the total energy consumed and carbon emitted during the construction and demolition of a building; a procedure commonly referred to as a Life Cycle Analysis or LCA (Brown, 2011). Based on previous analysis, conversion from parking to residential use requires approximately 6.2 kg of carbon emissions per square foot while demolition and construction of a new concrete structure requires approximately 30.2 kg per square foot and steel frame requires 14.8 kg/SF (Ibid). Assuming the alternative of demolition and new development of similar composition, repurposing the existing 9th and Neches parking garage would use 1.8% of the embodied energy required for new concrete construction and 3.7% of that required for new steel frame construction.

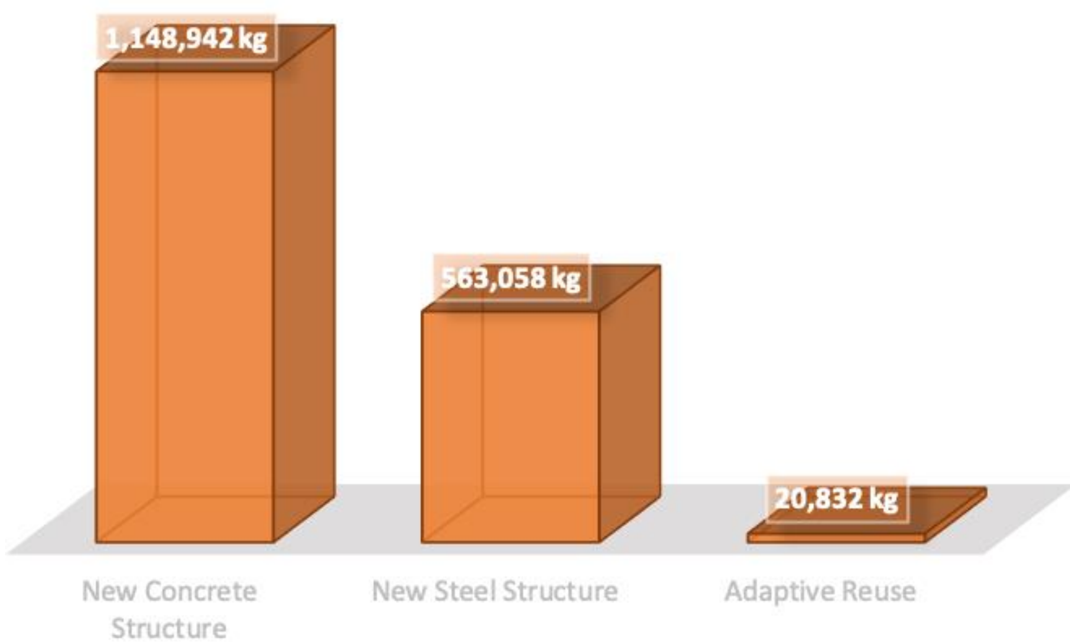

Figure 20 - Result of life cycle analysis

Limitations

While this analysis and previous case study demonstrate the upside to reuse of parking structures, there remain a number of limitations to its widespread application. It is clear that parking garages have and will continue to be built with low ceiling heights and ramped floors, limiting opportunities for repurposing (Gonzales and Ranostaj, 2018). This is evident in the results of the suitability analysis performed on five test structures in downtown Austin. Although not a statistically significant sample, the preliminary analysis suggest that it is that a majority of existing garages will not be suitable for reuse under the criteria described in the previous chapter.

Despite being out of the scope of this suitability analysis, live load bearing capacity is an additional limitation to the reuse of parking structures. The live load capacity of parking garages is often lower than required for office space and other commercial uses. The prototypical parking garage has a uniform live load of 40 pounds per square foot while office uses require structures that meet or exceed live loads of 50 psf (Cudney, 2018). The Summit Hotel demonstrated that this is not an inherently insurmountable obstacle by introducing a large atrium space within the interior of the structure that reduced loads on the existing columns (Simmons, 2020). However, without the application of creative and novel solutions, it is expected that a majority of existing parking structures could not be economically converted to other uses above the first floor (Cudney, 2018).

Design for Reuse

Case Study

It is increasingly clear that future parking structures will need to be designed with secondary uses in mind to meet sustainability objectives. Results from the suitability analysis reveal the many barriers to adaptive reuse in current construction methods. Architects, engineers, developers, and city planners have made progress in this area through the design of adaptable garages and land use plans that bring the need to embed flexibility into car-oriented infrastructure to the forefront. This section discusses examples of existing parking structures that are built with future repurposing in mind as well as policies and initiatives seeking to regulate parking structure construction methods.

Structural

Camden Properties

Camden Properties has incorporated modifications into its new standard parking garage design to ease conversion to other uses. In new garages the property developer uses conventional steel mats, where concrete is poured into a lattice of rebar each 12 inches apart, to increase the load bearing capacity of the garage and reduce bounce in flat floor plates. This technique requires cast-in-place concrete, meaning it is poured on site, rather than the standard precast slabs seen in typical parking structures (Camden Properties, 2019). Columns are spaced 27 feet apart, estimated to allow for an apartment between 600 and 700 SF to be constructed between them. Ramps are designed to be removed later and are lined by flat floors. Camden has used these design standards in multiple apartment developments in Colorado and California since 2015 (Ibid).

84.51° Headquarters

The headquarters of 84.51°, a consumer data analytics company, in Cincinnati, Ohio embedded a structured parking garage designed for reuse into its eight-story office building. The owner-occupied building conceived by architecture firm Gensler uses design elements throughout the 280,000 SF office space and multi-story garage to seamlessly transition from two separate uses into a cohesive space (Simmons, 2020). The three levels of parking are built with high ceilings, flat floors, and the same structural elements as levels devoted to office space. This includes “light canyons” that bring in natural light and create visual connections between workspaces, additional utility conduit, as well as similar interior and exterior design elements (Mannion, 2016). The space still operates as parking but is suitable for conversion to office space as the owner expands its workforce.

EPIC Tower

In Los Angeles, California developer Hudson Pacific Properties constructed the 15-story EPIC Tower with the potential to convert two floors of the structured parking podium to office space as demand for parking decreases (Simmons, 2020). The four-story parking podium is designed so that the concrete ceiling on every other level is removable and pre-wired for electricity to enable other commercial uses in the future (Camden Property, 2019). The office building, fully leased by video-streaming company Netflix, also incorporates vehicle drop-off zones for ride-sharing services along with storage racks and personal lockers for those who commute on bike. These features are part of an overall strategy to deemphasize parking in favor of a more multi-modal future (Garsten, 2019).

WGI FlexPark

Parking consulting company WGI Engineering has also developed a parking garage design that is suitable for conversion to other uses in a product called FlexPark. Eager to meet current parking demand but wary of long-term trends, the City of Grand Rapids in Michigan used WGI’s FlexPark system in the development of a new six-story public parking facility in the city’s downtown (Simmons, 2020). The site for the new parking garage was chosen because its location, directly adjacent to an existing parking structure, eliminated the need for interior ramps within the garage. Instead, the new parking structure is connected on all parking levels to the existing garage, allowing cars to go through existing ramps to access new parking spots. Aside from this unique characteristic, the structure's design also incorporates increased superimposed live loads, floor-to-ceiling heights over 11 feet, and mechanical and electrical systems on each level to accommodate future residential or office use (Ibid).

POLICY AND PLANNING

Miami, Florida

The City of Miami has begun to push for adaptable parking structures in recent planning documents. With a desire for more dense development patterns and environmental constraints on underground parking structures, the city requires innovative approaches to managing transitions in mobility patterns. In the recent masterplan for the Coconut Grove neighborhood, a recommendation that all parking structures are designed with a car-less future in mind is included within the land use objectives. The plan envisions a 15-year lifecycle in which a garage developed with 10-foot ceiling to ceiling heights and ramped circulation is phased into a completely retrofitted structure with a central courtyard replacing the ramp (Coconut Grove Business Improvement District, 2017). The same objective is reiterated in the city's master plan for new station-areas planned along the Tri-Rail commuter rail line. In the planning document, the city again encourages the development of parking structures with future reuse in mind along with other parking management policies designed to enhance multimodality in transit-oriented districts across the city (City of Miami, 2019). These initiatives include eliminating parking minimums, establishing parking maximums, requiring active first floor uses, and developing centrally located shared parking garages (Ibid).

Minneapolis, Minnesota

In Minneapolis, new changes to the land development code include many novel approaches to regulating the design and development of parking structures. The building code, amended in 2017, allowed for the development of new above-ground public parking facilities only in the case that specific design requirements are met and virtually eliminated single-use standalone parking structures (City of Minneapolis, 2017). The new code requires that new parking garages have commercial, residential, office, or hotel uses located between the parking garage and any public sidewalk, except where frontage is needed to provide access. Above the ground floor, space devoted to parking is limited to less than 30% of the linear frontage of each floor facing a public street, sidewalk, or pathway. The ordinance also requires that the gross floor area of above-grade parking garages cannot exceed the gross floor area of all other uses located on the same lot. Lastly, the amended code states that design features that facilitate conversion of parking garages to other uses, including flat floors, are strongly encouraged (Ibid).

FINANCIAL FEASIBILITY

Notably, the Miami plans and Minneapolis code fall short of outright requiring that all above-ground parking structures must be designed to be suitable for adaptive reuse. This is due, in part, to push back on the financial feasibility of parking structures with flat floor plates and higher ceiling clearances (Callaghan, 2017). Jason Wittenberg, manager of land use, design, and preservation for the City of Minneapolis, noted that in conversations with architects and developers he often heard that more strict regulations would make parking construction cost prohibitive (Ibid). However, evidence from the structural case studies examined demonstrates that the development of adaptable parking structures is financially feasible and can actually add value over the long-term lifecycle of building (Camden Properties, 2019; Simmons, 2020). This long-term outlook is relevant to owner-occupants - seen in the 84.51° and City of Grand Rapids cases - and REITs (Real Estate Investment Trusts) such as Camden Properties and Hudson Pacific Properties, both as long-term holders of real estate assets (Camden Properties, 2019). While not directly featured in the case study, developers taking on ambitious projects carried out over multiple phases may also benefit from the flexibility of adaptable garages that can be converted to active uses in later phases of development.

Financial Analysis

In order to better understand the implications of policies that require adaptable parking structures on development, a discounted cash flow analysis can assess the financial feasibility of any given real estate development. A comparative analysis between the expected returns of two office developments, one with a standard parking structure and the other with a FlexPark adaptable structure, can be used to reveal the financial implications of an ordinance designed to require adaptable parking structures. For ease of understanding, a prototypical 250,000 SF office tower with 8 stories of office space, each approximately 30,000 SF, accompanied by a 5-story parking podium of equal floorplate dimensions is used in each scenario. Operating income is forecasted over a 20-year period before the sale of the development in the final year. It is expected that parking structures built today will remain in the built environment for up to 50-years, so the long-term horizon was used to better understand how the upfront investment in an adaptable parking structure would impact expected returns over the life of the structure (Simmons, 2020).

Financial Assumptions

In the baseline scenario, it is assumed the parking structure is built using typical construction methods: pre-cast concrete, sloping floors, lower ceiling heights, and lack of utility connections. The adaptable parking garage is assumed to follow the FlexPark approach developed by WGI, including increased load bearing capacity, higher ceilings, exterior or removable ramp structure, flat floor plates, and utility hook-ups (Cudney, 2018). Each development is assumed to be constructed on the same, hypothetical parcel in downtown Austin. Market conditions, including expected construction costs and lease and parking revenues, are based on reports and forecasts for the Austin area. To model the impact of the adaptable parking structure, it is assumed that following year 10, one floor of the parking podium will be converted to office use, followed by a second floor after year 15. To account for the increase in construction cost, a 15% cost premium is added per parking space in the FlexPark Office construction budget (Simmons, 2020). Tenant allowances, totaling $179/SF of converted space, are allotted in years 11 and 15 to account for the cost of building out interior spaces of the converted floors (JLL, 2019). It is assumed that parking revenues depreciate at a rate of 2% each year, based on the aforementioned trends in urban mobility patterns. In all, the following financial and physical input assumptions are used:

FlexPark Office Development		
Input Assumptions		
Total SF	250,000	
Efficiency	90%	
Parking Spots Per 1000 SF	2.50	*Based on average parking ratio for office space in downtown Austin according to 2017 report by Aquila*
Parking Const. Cost Per Space	$ 24,725.00	*Based on cost per space for Flex Park provided by WGI*
Market Rent/SF	$ 55.00	*Based on rent estimation for CBD Class A office space in Austin by Colliers International*
Parking Revenue Per Space (Monthly)	$ 219.00	*Average cost per month for a reserved parking space in Downtown Austin according to a 2017 survey by Aquila*
Parking Revenue Depreciation	2.00%	*Assumed based on trends in mobility patterns*
Const. Costs/SF (Hard Costs)	$ 200.00	*Based on 2019 office construction cost survey by CBRE*
OpEx as % of GOI	20%	*Typical operating expenses for office space according to conversations with EPS*
Vacancy	9.0%	*Class A vacancy rate in Austin's CBD office market according to 2018 survey by Colliers International*
Tenant Allowance Per SF of Converted Parking	$ 179.00	*Based on high end figure from 2019 survey of average buildout costs per SF of Austin office space by JLL*
Loan Interest Rate	5.5%	*Average loan interest rate in commercial lending markets according to 2019 Q4 survey by CBRE*
Soft Costs as % of Project Budget	12%	*Based on 2019 office construction cost survey by CBRE*
Cost of Land as % of Project Budget	15%	*Based on construction cost survey in 2019 by Cushman & Wakefield*
Construction Loan Interest	7.75%	*Average construction loan interest rate according to 2020 survey by LendingTree*
Loan to Value	65%	*Based on Q3 survey of commercial real estate capital markets by CBRE*
Down Payment	$ 10,180,016	
Construction Period (# of Months)	18	
Initial Lease-up Period (# of months)	6	*Based on Austin office market forecast by Colliers International*
Rent Growth (Yearly)	1.10%	*Based on 2019 Q4 report by the Texas A&M Research Center*
Discount Rate	6.50%	*Lower end of typical 6-12% discount rate to simulate long-term holding strategy*
Exit Cap Rate	5.50%	Average Cap Rate for Austin CBD Class A Office from 2019 survey by CBRE

Baseline Office Development		
Input Assumptions		
Total SF	250,000	
Efficiency	90%	
Parking Spots Per 1000 SF	2.50	*Based on average parking ratio for office space in downtown Austin according to 2017 report by Aquila*
Parking Const. Cost Per Space	$ 21,500.00	*Based on cost per space for traditional parking garage provided by WGI*
Market Rent/SF	$ 55.00	*Based on rent estimation for CBD Class A office space in Austin by Colliers International*
Parking Revenue Per Space (Monthly)	$ 219.00	*Average cost per month for a reserved parking space in Downtown Austin according to a 2017 survey by Aquila*
Parking Revenue Depreciation	2.00%	*Assumed based on trends in mobility patterns*
Const. Costs/SF (Hard Costs)	$ 200.00	*Based on 2019 office construction cost survey by CBRE*
OpEx as % of GOI	20%	*Typical operating expenses for office space according to conversations with EPS*
Vacancy	9.0%	*Class A vacancy rate in Austin's CBD office market according to 2018 survey by Colliers International*
Loan Interest Rate	5.5%	*Average loan interest rate in commercial lending markets according to 2019 Q4 survey by CBRE*
Soft Costs as % of Project Budget	12%	*Based on 2019 office construction cost survey by CBRE*
Cost of Land as % of Project Budget	15%	*Based on construction cost survey in 2019 by Cushman & Wakefield*
Construction Loan Interest	7.75%	*Average construction loan interest rate according to 2020 survey by LendingTree*
Loan to Value	65%	*Based on Q3 survey of commercial real estate capital markets by CBRE*
Down Payment	$ 9,944,188	
Construction Period (# of Months)	18	
Initial Lease-up Period (# of months)	6	*Based on Austin office market forecast by Colliers International*
Rent Growth (Yearly)	1.10%	*Based on 2019 Q4 report by the Texas A&M Research Center*
Discount Rate	6.50%	*Lower end of typical 6-12% discount rate to simulate long-term holding strategy*
Exit Cap Rate	5.50%	Average Cap Rate for Austin CBD Class A Office from 2019 survey by CBRE

Figure 21 - Pro Forma financial assumptions

Calculated Outputs

Calculated outputs for each development demonstrate how the FlexPark construction standards impact project costs and built spaces. In their initial construction both developments have a parking density of 2.50 space per 1,000 leasable SF, the average ratio in Austin's CBD (Aquila, 2017). This equates to 563 parking spaces and nearly 40% of the built space devoted to parked cars. However, in the final years of the FlexPark scenario less than a quarter of the built space is for parking purposes after two floors have undergone full conversions to office space. The cost of the additional construction requirements results in an almost $2 million increase in the total cost of the 5-story parking podium and an overall project budget of $78 million compared to $76 million in the baseline scenario.

FlexPark Office Development		
Project Calculated Outputs		
Total Leasable SF (Phase I)		225,000
Total Parking Spaces (Phase I)		563
Total SF of Parking (270 SF per Space, Phase I)		151,875
% of Total SF Devoted to Parking (Phase I)		38%
Total Leasable SF (Phase III)		274,232
Total Parking Spaces (Phase III)		338
Total SF of Parking (270 SF per Space, Phase III)		91,260
% of Total SF Devoted to Parking (Phase III)		23%
Total Construction SF		401,875
Total Land Cost	$	8,400,000
Total Parking Cost	$	13,907,813
Building Construction	$	56,000,000
Construction Loan Amount	$	69,907,813
Total Cost of Project	$	78,307,813
Total Outside Equity Needed	$	27,407,734
Total Lending Needed	$	50,900,078

Parcel Outputs		
Maximum FAR		25:1
Minimum Lot Size (Acres)		0.23
Land Cost Per SF	$	840.00

Baseline Office Development		
Project Calculated Outputs		
Total Leasable SF		225,000
Total Parking Spaces		563
Total SF of Parking (270 SF per Space)		151,875
% of Total SF Devoted to Parking		38%
Total Construction SF		401,875
Total Land Cost	$	8,400,000
Total Parking Cost	$	12,093,750
Building Construction	$	56,000,000
Construction Loan Amount	$	68,093,750
Total Cost of Project	$	76,493,750
Total Outside Equity Needed	$	26,772,813
Total Lending Needed	$	49,720,938

Parcel Information		
Maximum FAR		25:1
Minimum Lot Size (Acres)		0.23
Land Cost Per SF	$	840.00

Figure 22 - Pro forma calculated outputs

Results

Preliminary results indicate that upfront investment in an adaptable parking structure will pay off over a 20-year period. Both the baseline and FlexPark office developments have a positive net present value, however the FlexPark scenario actually achieves a slightly higher NPV at $61 million compared to $57 million in the baseline. This is due to the higher operating income after the two floors are converted from parking to office space and begin to bring in lease revenue. In the final year, the FlexPark development is generating $39 of NOI per square foot compared to the baseline's $33. This increase in expected income results in a higher forecasted sales price in year 20. Additionally, the FlexPark development has a higher debt coverage ratio, at 3.05 compared to 2.78, in the final year of the forecast. While this marginal increase in NPV may not be enough to persuade the average developer to commit to the upfront investment, other benefits associated with the FlexPark construction method add to the equation. Parking area is not typically included in FAR calculations, allowing a developer to exceed the leasable space allowed under current regulations after conversion to office space or other uses. Additionally, the upfront investment allows developers to maintain the option to transition space away from parking use and to other uses depending on market conditions. For example, if parking demand falls much quicker than expected and market conditions favor office development, a hotel tower could convert parking floors to leasable office space, effectively repositioning the asset as circumstances change. Both of these factors are crucial to a developer's exit strategy, as they offer advantages typical products on the market cannot match.

FlexPark Office Development

Operating Pro Forma

		1	2	3	4	5	6	7	8	9	10
Market Rent/SF	$ 55.00	55.61	56.22	56.84	57.46	58.09	58.73	59.38	60.03	60.69	61.36
Gross Rent		$ 7,506,675	$12,648,747	$ 12,787,884	$ 12,928,550	$ 13,070,764	$13,214,543	$ 13,359,903	$ 13,506,862	$ 13,655,437	$ 13,805,647
Potential Gross Income		$ 7,506,675	$12,648,747	$ 12,787,884	$ 12,928,550	$ 13,070,764	$13,214,543	$ 13,359,903	$ 13,506,862	$ 13,655,437	$ 13,805,647
Vacancy Allowance		$ 375,334	$ 632,437	$ 639,394	$ 646,428	$ 653,538	$ 660,727	$ 667,995	$ 675,343	$ 682,772	$ 690,282
Effective Gross Income		$ 7,131,341	$12,016,310	$ 12,148,489	$ 12,282,123	$ 12,417,226	$12,553,816	$ 12,691,908	$ 12,831,519	$ 12,972,665	$ 13,115,365
Parking Income:		$ 1,479,564	$ 1,449,973	$ 1,420,973	$ 1,392,554	$ 1,364,703	$ 1,337,409	$ 1,310,660	$ 1,284,447	$ 1,258,758	$ 1,233,583
Total Revenue		$ 8,610,905	$13,466,283	$ 13,569,463	$ 13,674,677	$ 13,781,929	$13,891,224	$ 14,002,568	$ 14,115,966	$ 14,231,424	$ 14,348,948
Operating Expenses		$1,501,335	$2,529,749	$2,557,577	$2,585,710	$2,614,153	$2,642,909	$2,671,981	$2,701,372	$2,731,087	$2,761,129
Net Operating Income	**-$78,307,813**	$ 7,109,570	$10,936,533	$ 11,011,886	$ 11,088,967	$ 11,167,776	$11,248,316	$ 11,330,588	$ 11,414,594	$ 11,500,336	$ 11,587,818
NOI/SF		$ 19	$ 29	$ 29	$ 29	$ 30	$ 30	$ 30	$ 30	$ 31	$ 31
Tenant Allowances											
Net Cash Flow (Operations)		$ 7,109,570	$10,936,533	$ 11,011,886	$ 11,088,967	$ 11,167,776	$11,248,316	$ 11,330,588	$ 11,414,594	$ 11,500,336	$ 11,587,818
Net Cash Flow (Reversions)											
	-$78,307,813	$ 7,109,570	$10,936,533	$ 11,011,886	$ 11,088,967	$ 11,167,776	$11,248,316	$ 11,330,588	$ 11,414,594	$ 11,500,336	$ 11,587,818
Debt Service:			$14,429,284	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565
BTCF	-$78,307,813	$ 7,109,570	$ (3,492,750)	$ 6,376,321	$ 6,453,401	$ 6,532,211	$ 6,612,751	$ 6,695,022	$ 6,779,028	$ 6,864,771	$ 6,952,253
Debt Coverage Ratio			0.76	2.38	2.39	2.41	2.43	2.44	2.46	2.48	2.50
Present Value Cash Flows	-$78,307,813	$6,675,653	-$3,079,416	$5,278,631	$5,016,378	$4,767,735	$4,531,944	$4,308,289	$4,096,100	$3,894,750	$3,703,646

	11	12	13	14	15	16	17	18	19	20
Market Rent/SF	62.03	62.72	63.41	64.10	64.81	65.52	66.24	66.97	67.71	68.45
Gross Rent	$ 15,654,854	$ 15,827,057	$ 16,001,155	$ 16,177,168	$ 16,355,116	$ 17,967,969	$ 18,165,617	$ 18,365,439	$ 18,567,458	$ 18,771,700
Potential Gross Income	$ 15,654,854	$ 15,827,057	$ 16,001,155	$ 16,177,168	$ 16,355,116	$ 17,967,969	$ 18,165,617	$ 18,365,439	$ 18,567,458	$ 18,771,700
Vacancy Allowance	$ 782,743	$ 791,353	$ 800,058	$ 808,858	$ 817,756	$ 898,398	$ 908,281	$ 918,272	$ 928,373	$ 938,585
Effective Gross Income	$ 14,872,111	$ 15,035,704	$ 15,201,097	$ 15,368,309	$ 15,537,361	$ 17,069,571	$ 17,257,336	$ 17,447,167	$ 17,639,085	$ 17,833,115
Parking Income:	$ 98,550	$ 96,579	$ 94,647	$ 92,754	$ 90,899	$ 73,978	$ 72,499	$ 71,049	$ 69,628	$ 68,235
Total Revenue	$ 14,970,661	$ 15,132,283	$ 15,295,745	$ 15,461,064	$ 15,628,260	$ 17,143,549	$ 17,329,835	$ 17,518,215	$ 17,708,713	$ 17,901,351
Operating Expenses	$3,130,971	$3,165,411	$3,200,231	$3,235,434	$3,271,023	$3,593,594	$3,633,123	$3,673,088	$3,713,492	$3,754,340
Net Operating Income	$ 11,839,690	$ 11,966,872	$ 12,095,514	$ 12,225,630	$ 12,357,237	$ 13,549,955	$ 13,696,711	$ 13,845,128	$ 13,995,222	$ 14,147,010
NOI/SF	$ 32	$ 32	$ 32	$ 33	$ 33	$ 37	$ 37	$ 38	$ 38	$ 39
Tenant Allowances	$ (4,897,762)					$ (3,914,730)				
Net Cash Flow (Operations)	$ 6,941,928	$ 11,966,872	$ 12,095,514	$ 12,225,630	$ 12,357,237	$ 9,635,225	$ 13,696,711	$ 13,845,128	$ 13,995,222	$ 14,147,010
Net Cash Flow (Reversions)										$ 257,218,372
	$ 6,941,928	$ 11,966,872	$ 12,095,514	$ 12,225,630	$ 12,357,237	$ 9,635,225	$ 13,696,711	$ 13,845,128	$ 13,995,222	$ 271,365,383
Debt Service:	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565	$ 4,635,565
BTCF	$ 2,306,363	$ 7,331,307	$ 7,459,948	$ 7,590,065	$ 7,721,672	$ 4,999,660	$ 9,061,146	$ 9,209,562	$ 9,359,656	$ 266,729,818
Debt Coverage Ratio	2.55	2.58	2.61	2.64	2.67	2.92	2.95	2.99	3.02	3.05
Present Value Cash Flows	$1,153,671	$3,443,389	$3,289,962	$3,143,048	$3,002,391	$1,825,352	$3,106,274	$2,964,463	$2,828,898	$75,697,130

Final Outputs	
Unlevered IRR:	13%
Levered IRR:	11%
Average NOI/SF	$ 32
Net Present Value:	$ 61,340,477

Baseline Office Development

Operating Pro Forma

		1	2	3	4	5	6	7	8	9	10
Market Rent/SF	$ 55.00	55.61	56.22	56.84	57.46	58.09	58.73	59.38	60.03	60.69	61.36
Gross Rent		$ 7,506,675	$12,648,747	$ 12,787,884	$ 12,928,550	$ 13,070,764	$13,214,543	$ 13,359,903	$ 13,506,862	$ 13,655,437	$ 13,805,647
Potential Gross Income		$ 7,506,675	$12,648,747	$ 12,787,884	$ 12,928,550	$ 13,070,764	$13,214,543	$ 13,359,903	$ 13,506,862	$ 13,655,437	$ 13,805,647
Vacancy Allowance		$ 375,334	$ 632,437	$ 639,394	$ 646,428	$ 653,538	$ 660,727	$ 667,995	$ 675,343	$ 682,772	$ 690,282
Effective Gross Income		$ 7,131,341	$12,016,310	$ 12,148,489	$ 12,282,123	$ 12,417,226	$12,553,816	$ 12,691,908	$ 12,831,519	$ 12,972,665	$ 13,115,365
Parking Income:		$ 1,479,564	$ 1,449,973	$ 1,420,973	$ 1,392,554	$ 1,364,703	$ 1,337,409	$ 1,310,660	$ 1,284,447	$ 1,258,758	$ 1,233,583
Total Revenue		$ 8,610,905	$13,466,283	$ 13,569,463	$ 13,674,677	$ 13,781,929	$13,891,224	$ 14,002,568	$ 14,115,966	$ 14,231,424	$ 14,348,948
Operating Expenses		$1,501,335	$2,529,749	$2,557,577	$2,585,710	$2,614,153	$2,642,909	$2,671,981	$2,701,372	$2,731,087	$2,761,129
Net Operating Income	**-$76,493,750**	$ 7,109,570	$10,936,533	$ 11,011,886	$ 11,088,967	$ 11,167,776	$11,248,316	$ 11,330,588	$ 11,414,594	$ 11,500,336	$ 11,587,818
NOI/SF		$ 19	$ 29	$ 29	$ 29	$ 30	$ 30	$ 30	$ 30	$ 31	$ 31
Net Cash Flow (Operations)		$ 7,109,570	$10,936,533	$ 11,011,886	$ 11,088,967	$ 11,167,776	$11,248,316	$ 11,330,588	$ 11,414,594	$ 11,500,336	$ 11,587,818
Net Cash Flow (Reversions)											
	-$76,493,750	$ 7,109,570	$10,936,533	$ 11,011,886	$ 11,088,967	$ 11,167,776	$11,248,316	$ 11,330,588	$ 11,414,594	$ 11,500,336	$ 11,587,818
Debt Service			$14,081,403	$4,513,326	$4,513,326	$4,513,326	$4,513,326	$4,513,326	$4,513,326	$4,513,326	$4,513,326
BTCF	-$76,493,750	$ 7,109,570	$ (3,144,869)	$ 6,498,560	$ 6,575,641	$ 6,654,450	$ 6,734,990	$ 6,817,262	$ 6,901,268	$ 6,987,011	$ 7,074,493
Debt Coverage Ratio			0.78	2.44	2.46	2.47	2.49	2.51	2.53	2.55	2.57
Present Value Cash Flows	-$76,493,750	$6,675,653	-$2,772,703	$5,379,827	$5,111,398	$4,856,956	$4,615,719	$4,386,950	$4,169,961	$3,964,103	$3,768,767

Final Outputs	
Unlevered IRR:	13%
Levered IRR:	11%
Average NOI/SF	$ 30
Net Present Value:	$ 57,357,559

	11	12	13	14	15	16	17	18	19	20
Market Rent/SF	62.03	62.72	63.41	64.10	64.81	65.52	66.24	66.97	67.71	68.45
Gross Rent	$ 13,957,509	$ 14,111,042	$ 14,266,263	$ 14,423,192	$ 14,581,847	$ 14,742,247	$ 14,904,412	$ 15,068,361	$ 15,234,113	$ 15,401,688
Potential Gross Income	$ 13,957,509	$ 14,111,042	$ 14,266,263	$ 14,423,192	$ 14,581,847	$ 14,742,247	$ 14,904,412	$ 15,068,361	$ 15,234,113	$ 15,401,688
Vacancy Allowance	$ 697,875	$ 705,552	$ 713,313	$ 721,160	$ 729,092	$ 737,112	$ 745,221	$ 753,418	$ 761,706	$ 770,084
Effective Gross Income	$ 13,259,634	$ 13,405,490	$ 13,552,950	$ 13,702,032	$ 13,852,755	$ 14,005,135	$ 14,159,192	$ 14,314,943	$ 14,472,407	$ 14,631,604
Parking Income:	$ 1,208,912	$ 1,184,733	$ 1,161,039	$ 1,137,818	$ 1,115,061	$ 1,092,760	$ 1,070,905	$ 1,049,487	$ 1,028,497	$ 1,007,927
Total Revenue	$ 14,468,545	$ 14,590,223	$ 14,713,989	$ 14,839,850	$ 14,967,816	$ 15,097,895	$ 15,230,097	$ 15,364,430	$ 15,500,904	$ 15,639,531
Operating Expenses	$2,791,502	$2,822,208	$2,853,253	$2,884,638	$2,916,369	$2,948,449	$2,980,882	$3,013,672	$3,046,823	$3,080,338
Net Operating Income	$ 11,677,043	$ 11,768,015	$ 11,860,736	$ 11,955,212	$ 12,051,447	$ 12,149,446	$ 12,249,214	$ 12,350,757	$ 12,454,082	$ 12,559,193
NOI/SF	$ 31	$ 31	$ 31	$ 32	$ 32	$ 32	$ 32	$ 33	$ 33	$ 33
Net Cash Flow (Operations)	$ 11,677,043	$ 11,768,015	$ 11,860,736	$ 11,955,212	$ 12,051,447	$ 12,149,446	$ 12,249,214	$ 12,350,757	$ 12,454,082	$ 12,559,193
Net Cash Flow (Reversions)										$ 228,348,968
	$ 11,677,043	$ 11,768,015	$ 11,860,736	$ 11,955,212	$ 12,051,447	$ 12,149,446	$ 12,249,214	$ 12,350,757	$ 12,454,082	$ 240,908,161
Debt Service	$4,513,326	$4,513,326	$4,513,326	$4,513,326	$4,513,326	$4,513,326	$4,513,326	$4,513,326	$4,513,326	$4,513,326
BTCF	$ 7,163,718	$ 7,254,689	$ 7,347,410	$ 7,441,886	$ 7,538,121	$ 7,636,120	$ 7,735,889	$ 7,837,432	$ 7,940,756	$ 236,394,835
Debt Coverage Ratio	2.59	2.61	2.63	2.65	2.67	2.69	2.71	2.74	2.76	2.78
Present Value Cash Flows	$3,583,379	$3,407,403	$3,240,331	$3,081,687	$2,931,022	$2,787,912	$2,651,959	$2,522,788	$2,400,045	$67,088,152

Figure 23 - Pro Forma discounted cash flow analysis and results

Conclusion

Car-oriented development has been a central component of American city planning. Parking ratios are one of the most widespread planning tools across the United States (Shoup, 1990). However, as the environmental damage of polluting cars and trucks has become apparent, the need to challenge this status quo has increased. Evidence indicates that the parking garage plays an outsized role in continuing car-oriented commuting patterns, has a particularly negative impact on the functionality of the urban core, compounds mounting affordability crises across cities in the United States, and is quickly losing its legitimacy as a useful building type going forward. Municipalities must rise to this occasion and better articulate the need to design structures for reuse. Impacts on embodied energy alone demonstrate the need for forward thinking on this issue by the public sector, no matter the cost of construction. The need to better manage parking must be part of any comprehensive plans in mobility, affordability, and sustainability. How we find clever methods to reuse existing relics of a wasteful past and invent techniques to embed flexibility into new ones, defines how planning has learned from its own past.

This report examines the possibilities for reuse of existing parking infrastructure and the rationale for its reuse and offers policy options to better manage the supply of parking and necessary transitions as transportation technology shifts. Research reveals a compelling argument for the need to find innovative solutions as the transportation sector continues to transition to a car-free future. The case studies and demonstrations in the reuse of parking garages shed light on the potential of existing structures in a rational argument for their reuse. By outlining the benefits to adaptive reuse, this paper makes the argument based not only on the value proposition to a potential developer, but through a wider benefit to the community. However, this paper is realistic about the inherent challenges to the reuse of parking garages. It is clear that parking garages have and will continue to be built with low ceiling heights and ramped floors, limiting opportunities for repurposing (Gonzales, 2018). This is evident in the results of the suitability analysis performed on five test structures in downtown Austin. Although not a statistically significant sample, the preliminary analysis revealed that a majority of existing garages will not be suitable for reuse under the criteria described in the previous chapter. It is increasingly clear that future parking structures will need to be designed with secondary uses in mind to meet sustainability objectives. Structural and policy examples addressing the need to design parking structures with repurposing in mind demonstrates the need for the widespread application of these practices. Lastly, the financial feasibility analysis reveals that this investment will generate a return over the lifespan of the structure.

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